

representations include a graphical representation in the form of a graph, a numerical representation in the form of a table of values, and a symbolic representation in the form of an equation expressed in terms of standard mathematical nomenclature, wherein one of the displayed representations is the graphical representation; (c) 306

- (c) manipulating the graphical representation; and (c) 306
- (d) processing the manipulation to substantially simultaneously and correspondingly update the other displayed representation of the mathematical relationship in accordance with the manipulation of the graphical representation,

whereby a user of the method is able to substantially immediately observe the effect of changes made to the graphical representation via its manipulation on the other of the at least two displayed representations.

(c) 306, Abs, cel 26-11, cel 25-44, cel 25-11, cel 25-14, cel 25-33

2. (original) A method as claimed in claim 1 wherein the step of defining a mathematical equation includes selecting a mathematical equation from a list of predefined mathematical equations. cel 9 in 161

3. (original) A method as claimed in claim 2 wherein the list of predefined mathematical equations includes equations selected from one or more of:

- (a) linear mathematical relations;
- (b) polynomial mathematical relations;
- (c) exponential mathematical relations;
- (d) logarithmic mathematical relations;
- (e) power mathematical relations;
- (f) trigonometric mathematical relations; and
- (g) conic section mathematical relations.

4. (original) A method as claimed in claim 2 wherein the list of predefined mathematical equations includes at least two equations selected from::

- (a) a linear mathematical equation described by  $y = m(x - h) + k$ ;
- (b) a quadratic mathematical equation described by  $y = a(x - h)^2 + k$ ;
- (c) a circular mathematical equation described by  $(x - h)^2 + (y - k)^2 = r^2$ ;
- (d) an elliptical mathematical equation described by  $\frac{(x - h)^2}{a^2} + \frac{(y - k)^2}{b^2} = 1$ ;
- (e) a hyperbolic mathematical equation described by  $\frac{(x - h)^2}{a^2} - \frac{(y - k)^2}{b^2} = 1$ ;
- (f) a hyperbolic mathematical equation described by  $\frac{(y - k)^2}{b^2} - \frac{(x - h)^2}{a^2} = 1$ ;
- (g) a parabolic mathematical equation described by  $y = m(x - h)^2 + k$ ;
- (h) a parabolic mathematical equation described by  $(y - k^2) = c(x - h)$ ;
- (i) a general exponential mathematical equation described by  $y = ba^x + k$ ;
- (j) a natural exponential mathematical equation described by  $y = be^{ax} + k$ ;
- (k) a logarithmic mathematical equation of the form  $y = b \ln(a(x - h)) + k$ ;
- (l) a power mathematical equation described by  $y = a(x - h)^r + k$ ;
- (m) a sine mathematical equation described by  $y = b \sin(a(x - h)) + k$ ; and
- (n) a cosine mathematical equation described by  $y = b \cos(a(x - h)) + k$ ;

where x and y are variable parameters and a, b, m, h, k and r are parameters according to standard mathematical nomenclature, the numerical values for which included in a particular predefined mathematical relation are user definable.

5. (original) A method as claimed in claim 1 wherein manipulation mechanisms available for manipulating the graphical representation of the mathematical relation include:

- (a) translating the graph with respect to a set of coordinate axes; and
- (b) dilating the graph with respect to a set of coordinate axes.

6. (original) A method as claimed in claim 1 wherein the method is performed using a programmed computer in combination with a stylus device.

7. (original) An interactive method for demonstrating an interrelationship between representations of a mathematical relationship, one of which representations is a graphical representation of the relationship relative to co-ordinate axes, the method including:

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cont:
- (a) simultaneously displaying on a visual display a mathematical relation in the form of the graphical representation and in another format being either an algebraic formula or a tabulated set of data which describes the graph or both;
  - (b) locating a stylus on the graphical representation on a position sensing screen associated with the visual display and a processor for the position sensing device to sense stylus position and provide stylus position data to the processor;
  - (c) moving the stylus over the position sensing screen for the processor to process changing stylus position data and manipulate the displayed graphical representation to change its shape or position relative to the co-ordinate axes in accordance with the motion of the stylus over the position sensing screen;
  - (d) wherein displayed information in said another format is substantially simultaneously and correspondingly changed to continually describe the graph as it is manipulated;
- whereby a user of the method is able to substantially immediately observe the effect of changes made to the graphical representation via its manipulation on said another of the displayed representations.

8. (original) Apparatus for interactively demonstrating an interrelationship between different representations of a mathematical relation, the apparatus including

a visual display device and a position sensitive touch screen associated with the visual display device, a processor operatively linked with

the visual display device and the touch screen, and a memory for storing application software, data and visual display information for the processor, visual display device and touch screen;

the visual display device and position sensitive touch screen providing for definition by use of a stylus of a mathematical equation;

wherein the visual display device simultaneously displays at least two of multiple possible representations of the defined mathematical equation, the multiple possible representations including a graphical representation in the form of a graph, a numerical representation in the form of a table of relation values, and a symbolic representation in the form of an equation expressed in terms of standard mathematical nomenclature,

and wherein the graphical representation is selectable for display as one of said at least two displayed representations;

wherein a stylus is positionable on the touch screen on the graphical representation and movable over the touch screen to generate changing position data, the apparatus being responsive to said changing position data for the visual display device to display in real time a manipulation of the graphical representation corresponding to the movement of the stylus;

and wherein the apparatus is also responsive to said changing position data to substantially simultaneously and correspondingly update the other displayed representation of the mathematical relationship in accordance with the manipulation of the graphical representation; whereby a user is able to substantially immediately observe the effect of changes made to the graphical representation via its manipulation on the other of the at least two displayed representations.

9. (original) Apparatus as claimed in claim 8 wherein the visual display device and position sensitive touch screen provide for selection of a mathematical equation from a list of predefined mathematical equations stored in the memory whereby the mathematical equation is definable.

10. (original) Apparatus as claimed in claim 9 wherein the list of predefined mathematical equations stored in the memory includes equations selected from one or more of:

- (a) linear mathematical relations;
- (b) polynomial mathematical relations;
- (c) exponential mathematical relations;
- (d) logarithmic mathematical relations;
- (e) power mathematical relations;
- (f) trigonometric mathematical relations; and
- (g) conic section mathematical relations.

11. (original) Apparatus as claimed in claim 9 wherein the list of predefined mathematical equations stored in the memory includes at least two equations selected from:

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cont:
- (a) a linear mathematical equation described by  $y = m(x - h) + k$ ;
  - (b) a quadratic mathematical equation described by  $y = a(x - h)^2 + k$ ;
  - (c) a circular mathematical equation described by  $(x - h)^2 + (y - k)^2 = r^2$ ;
  - (d) an elliptical mathematical equation described by  $\frac{(x - h)^2}{a^2} + \frac{(y - k)^2}{b^2} = 1$ ;
  - (e) a hyperbolic mathematical equation described by  $\frac{(x - h)^2}{a^2} - \frac{(y - k)^2}{b^2} = 1$ ;
  - (f) a hyperbolic mathematical equation described by  $\frac{(y - k)^2}{b^2} - \frac{(x - h)^2}{a^2} = 1$ ;
  - (g) a parabolic mathematical equation described by  $y = m(x - h)^2 + k$ ;
  - (h) a parabolic mathematical equation described by  $(y - k^2) = c(x - h)$ ;
  - (i) a general exponential mathematical equation described by  $y = ba^x + k$ ;
  - (j) a natural exponential mathematical equation described by  $y = be^{ax} + k$ ;
  - (k) a logarithmic mathematical equation of the form  $y = b \ln(a(x - h)) + k$ ;
  - (l) a power mathematical equation described by  $y = a(x - h)^r + k$ ;
  - (m) a sine mathematical equation described by  $y = b \sin(a(x - h)) + k$ ; and

(n) a cosine mathematical equation described by  $y = b\cos(a(x - h)) + k$  ;  
where x and y are variable parameters and a, b, m, h, k and r are parameters according to standard mathematical nomenclature, the numerical values for which included in a particular predefined mathematical relation are user definable.

12. (original) Apparatus as claimed in claim 8 wherein the application software provides manipulation mechanisms for manipulating the graphical representation of the mathematical equation which include

- (a) translating the graph with respect to a set of coordinate axis;
- (b) dilating the graph with respect to a set of coordinate axis.

13. (original) Apparatus as claimed in claim 8 which is a hand-held computer device.

14. (original) A hand held computer device for demonstrating an interrelationship between different representations of a mathematical relationship, including

- (a) a visual display unit for displaying multiple representations of a mathematical relationship, wherein the available representations include:
  - (i) a graphical representation,
  - (ii) a numerical representation in the form of tabulated data, and
  - (iii) a symbolic representation in the form of a mathematical equation;
- (b) a memory for storing application software, data, and visual display information;
- (c) a stylus;
- (d) a position sensing touch screen associated with the visual display unit; and
- (e) a processor coupled to the visual display unit, memory, and position sensing device touch screen, for updating multiple representations of

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the mathematical relationship according to a manipulation of a graphical representation displayed on the visual display unit, wherein the manipulation of the graphical representation occurs in response to a motion of the stylus on the position sensing touch screen; whereby a user of the device is able to substantially immediately observe the effect of changes made to the graphical representation via its manipulation on the other of the at least two displayed representations.

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